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January 9, 2022

TO: Johnston Architects

SUBJECT: Design Submittal - Geopier Soil Reinforcement REVISED
Mercer Island Mixed-Use Development
Mercer Island, WA

This letter and the attached documents represent our design submittal for Geopier® soil reinforcement at the site of the Mercer Island Mixed-Use development located in Mercer Island, WA. The following paragraphs document our design of the Geopier-Rampact reinforcement system for support of the mat foundations. Based on the geotechnical report and project documents it is assumed that the ground improvement will only be required west of Gridline G and that east of Gridline G the mat foundation will be founded on competent native soils.

Geopier Reinforcement Design

Subsurface information, as documented in the geotechnical report completed by Hart Crowser Inc., has been used as a basis for our design. Below are the simplified soil soil conditions:

- Loose to medium dense silty granular FILL, soft SILT and PEAT to variable depths between El.87 ft and El.62 ft.
- Underlain by interbedded layers of medium to hard SILT and silty CLAY and medium dense to dense SAND and silty SAND to the maximum exploration at about El.40ft.
- At about El. 69 ft, where Geopier installation will occur, soils predominantly consist of very soft and soft SILT to about El. 62 ft. In the southeast portion of building footprint, soils consist of very stiff to hard SILT and dense to very dense SAND.
- Groundwater was encountered at variable depths between 7.5 and 35 feet (assumed to be perched water). We have assumed a water table at elevation 69.

The geotechnical cross sections and elevation of competent bearing soils are presented in Appendix A: Geotechnical Information. Please note that their estimates for competent bearing soil elevations are approximate and our design is meant to address uncertainty in competent bearing elevations by having Geopier elements extend much deeper if practical refusal is not encountered.

In view of the loose/soft to medium dense/stiff sandy and silty soils, the Geopier-Rampact system or “displacement process” will be used to install the Geopier elements. The Geopier-Rampact system which we propose to utilize consists of a hollow mandrel with an internal compaction surface which is driven into the ground using a powerful static down force augmented by dynamic vertical impact energy. After driving to the design depth, the hollow mandrel serves as a conduit for aggregate placement. As the mandrel is raised and redriven downward thin lifts of compacted aggregate are formed and compacted both vertically and laterally. The process is repeated until the rammed aggregate pier is constructed. We anticipate installing Geopier elements from the approximate elevation between 68 and 69 ft. It should be noted that we anticipate encountering refusal on the competent bearing soils noted in the geotechnical report. These competent native soils are anticipated to be encountered between elevations of 63 and 83 feet, refer to Figure 10 of the geotechnical report. Therefore, we anticipate reaching the competent soils prior to the maximum installation depth of 15 feet and do not have a required minimum length as we are improving the soil above the competent bearing soils. The the competent soil contours presented in Figure 10 of the geotechnical report will be utilized in the field to determine if refusal was encountered on the competent bearing layer and is included in Appendix A: Geotechnical Information.

The mandrel will be driven to the dense to very dense soil conditions. Geopier elements will be installed to 15 feet or refusal below the planned FFE. Practical refusal is considered less than 1 foot of mandrel advancement in 30 seconds.

The Geopier reinforcement has been designed to support the structure based on the loading provided by the structural engineer with a maximum allowable bearing capacity of up to 3,000 psf which can be increased by 1/3 for short duration. Actual loading of the mat provided by the structural engineer reveals an average bearing pressure of 1,500 psf. We have utilized the actual pressures for the settlement calculations/estimations as presented in Appendix C: Settlement Calculations. The design allowable bearing capacity calculations are presented in Appendix D: Bearing Capacity and utilize the full 3,000 psf bearing pressure. The bearing pressure calculations yielded acceptable factors of safety. It is important to note that the actual loads are utilized to calculate the estimated settlements otherwise settlement estimates will be vastly overstated.

Our Geopier elements will be installed directly beneath the mat foundations on an approximate maximum grid spacing of 6 feet on-center to provide adequate static support.

<u>Spread Foundation Settlement</u>

For our analysis, settlements are first calculated for a zone extending from the bottom of the footing to the depth of the reinforcement. Additional settlement may occur in the “lower zone” or in the unimproved soil beneath the reinforced zone. The lower zone settlement is calculated using a consolidation approach. We have included calculations for the longest possible Geopier elements and a short Geopier element. We have also estimated the settlement of the mat foundation not supported by Geopier elements at approximately 1.0 inches based on our lower zone parameters extending to 100 feet. This settlement was estimated to check on the potential for differential settlement.

Our settlement utilized the following soil profile:

- 2 to 7 feet of very soft to soft silt (ML) underlain by
- 2 feet of transitional material between the soft silt (ML) and stiff silt (ML)
- 20 feet of stiff to very stiff sandy silt (ML) underlain by
- Hard Silt (ML)

Estimated settlements at the center of the Mat were the following:

- Deep Geopier Elements – 1.4 inches of total settlement
- Shallow Geopier Elements – 1.0 inches of total settlement
- Mat Foundation without Geopier Elements – 1.0 inches of total settlement

Based on our calculations, total settlements for the mat foundation should range between 1.0 and 1.4 inches with a maximum of 0.5 inches of differential settlement over 40 feet. Additionally, it should be noted that a large portion of the settlement will occur during construction as the settlement due to the dead loads will occur during construction so total post-construction settlements should be less than 1 inch. Please see our attached calculations for in Appendix C: Settlement Calculations for additional information.

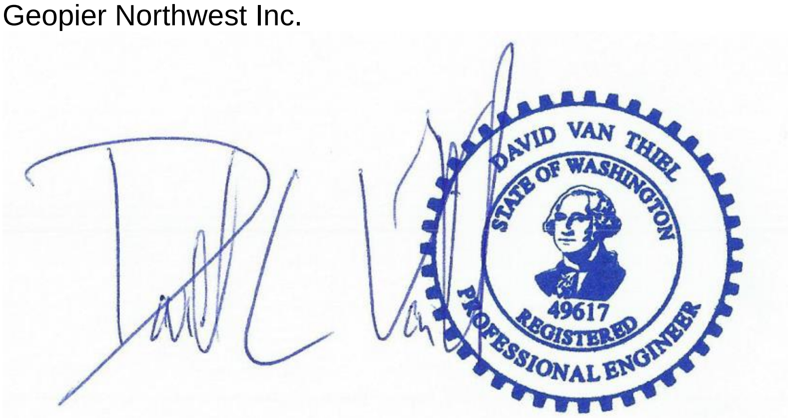
The Geopier design does not include liquefaction mitigation. While our tight spacing of 6 ft o.c. will provide improved seismic performance and liquefaction mitigation it has not been included as part of the design. Therefore, we conservatively recommend that the structural design of the mat foundation accommodate the amount of potential liquefaction settlement discussed in the geotechnical report.

Geopier Installation and Modulus Testing

The installation of the Geopier reinforcement, including a downward modulus test, will be completed in general accordance with the specifications. The installation and the modulus test will be conducted under the supervision of an experienced geotechnical engineer from Geopier Northwest. The modulus test will consist of loading the Geopier element in increments to 150% of the design load while measuring deflections to verify the design parameters. The modulus test will also incorporate a creep test at 115% of the design load.

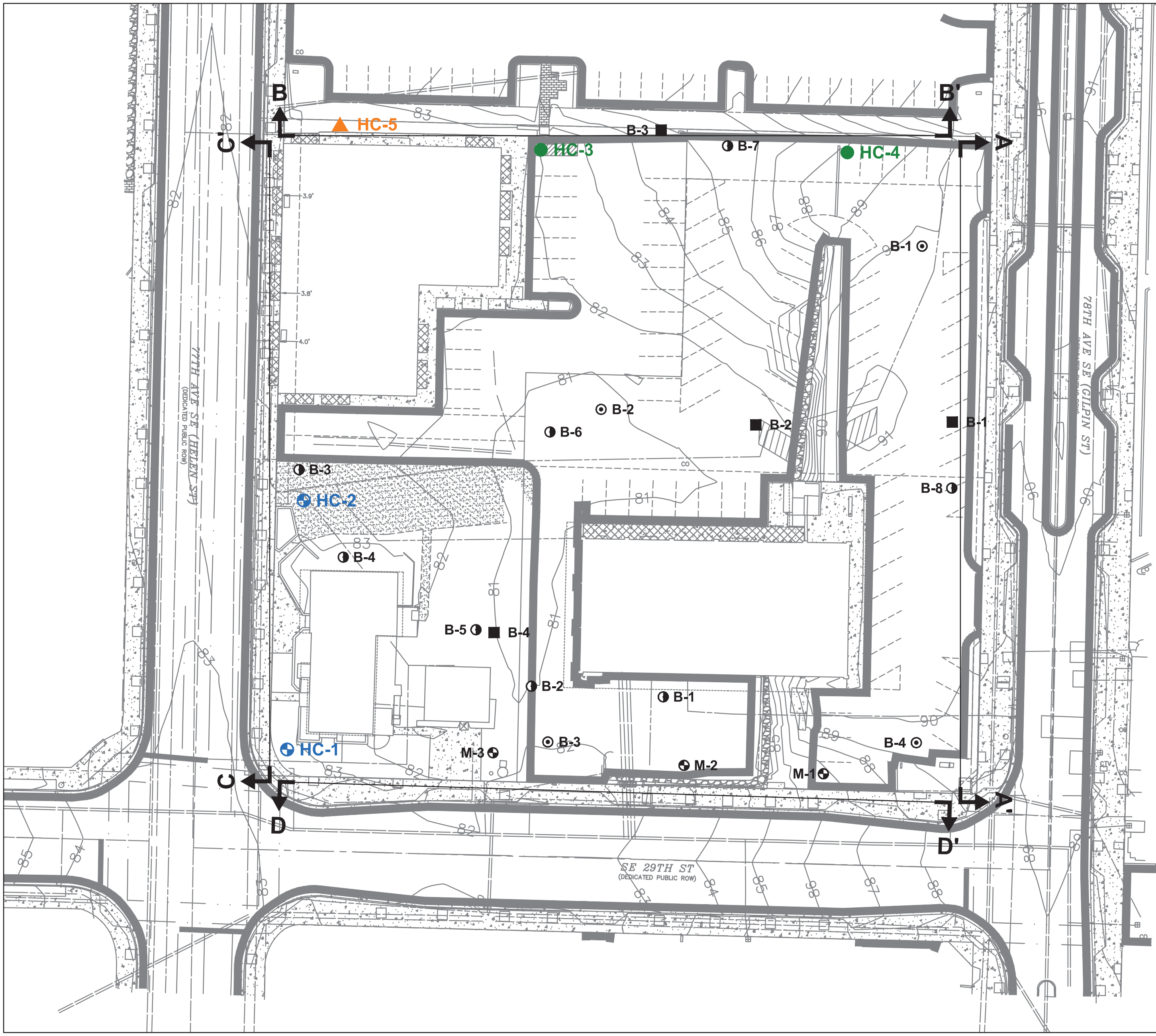
We appreciate the opportunity to work with you on this project. If you have any questions or require further information, please call.

Sincerely,
Geopier Northwest Inc.



David Van Thiel, P.E., G.E.

Appendix A: Geotechnical Information



Current Exploration Location and Number

HC-3 ● Boring (Hart Crowser)

HC-5 ▲ Hand Probe (Hart Crowser)

HC-1 Monitoring Well (Hart Crowser)

Previous Exploration Location and Number

B-1 ■ Boring (ABPB Consulting)

B-6 ◑ Push Probe (Farallon)

M-1 Monitoring Well (ABPB Consulting)

B-1 ⊙ Boring (Terra)

A A' Approximate Cross Section Location and Designation

N

0 40 80

Scale in Feet

Source: Base map prepared from survey "XS-ALTA-02.dwg," created by Bush, Roed & Hitchings, dated 10/14/14.

Mercer Island Multi-Family Development
Mercer Island, Washington

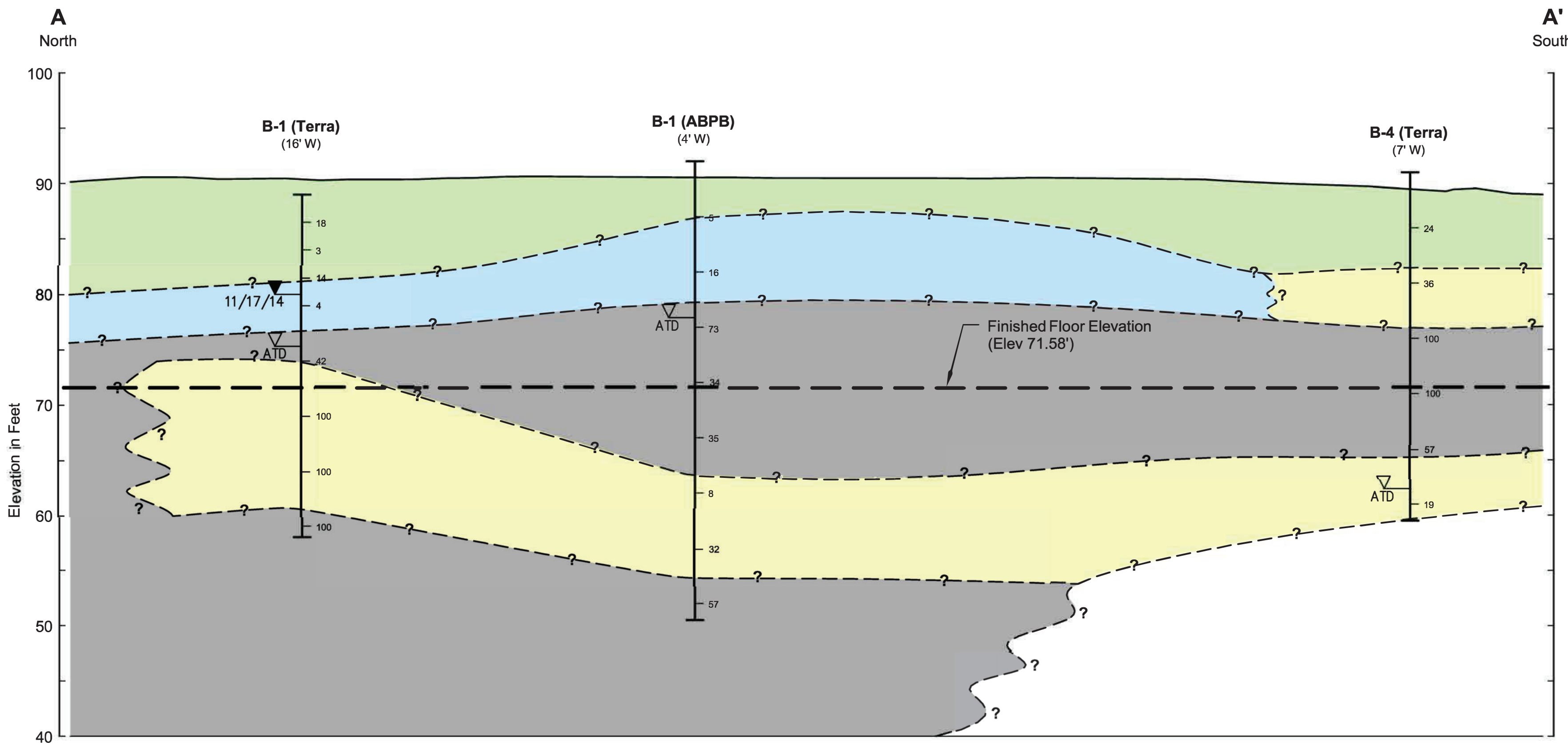
Site and Exploration Plan

19413-00 10/20

HARTCROWSER
A division of Haley & Aldrich

Figure
2

EAL 10/27/20 1941300-001 (SPlan).dwg



Legend

B-1 (Terra) (16' W)	Exploration Number (Offset Distance and Direction)		**Unit 1** Loose to medium dense granular FILL, soft SILT, and PEAT
	Exploration Location		**Unit 2** Medium stiff to hard SILT and silty CLAY
ATD	Water Level		**Unit 3** Medium dense to dense SAND and silty SAND
9	Standard Penetration Resistance in Blows per Foot		**Unit 4** Hard SILT
	Finished Floor Elevation Johnston Architects, LLC Plans dated 10/1/2020		

Horizontal Scale in Feet
0 20 40

0 10 20
Vertical Scale in Feet
Vertical Exaggeration x 2

Mercer Island Multi-Family Development
Mercer Island, Washington

Generalized Subsurface Cross Section A-A'

19413-00 10/20

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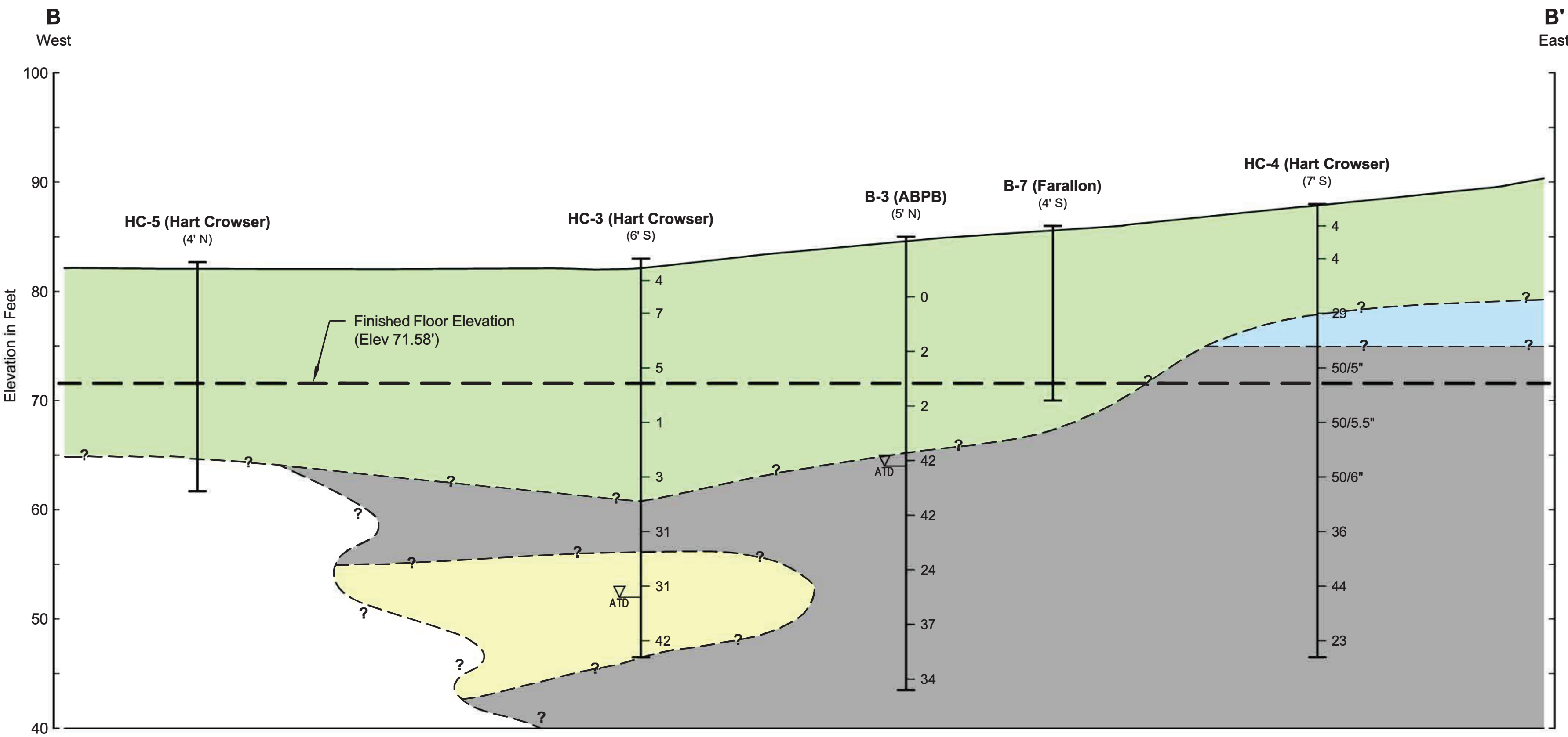
Figure
3

EAL 10/28/20 194130-002 (XSec).dwg



Legend

B-1 (Terra) (16' W)	Exploration Number (Offset Distance and Direction)
	Exploration Location
ATD	Water Level
9	Standard Penetration Resistance in Blows per Foot
	Finished Floor Elevation Johnston Architects, LLC Plans dated 10/1/2020

Unit 1
Loose to medium dense granular FILL, soft SILT, and PEAT

Unit 2
Medium stiff to hard SILT and silty CLAY

Unit 3
Medium dense to dense SAND and silty SAND

Unit 4
Hard SILT

Horizontal Scale in Feet
0 20 40

0 10 20
Vertical Scale in Feet
Vertical Exaggeration x 2

Mercer Island Multi-Family Development
Mercer Island, Washington

Generalized Subsurface Cross Section B-B'

19413-00 10/20

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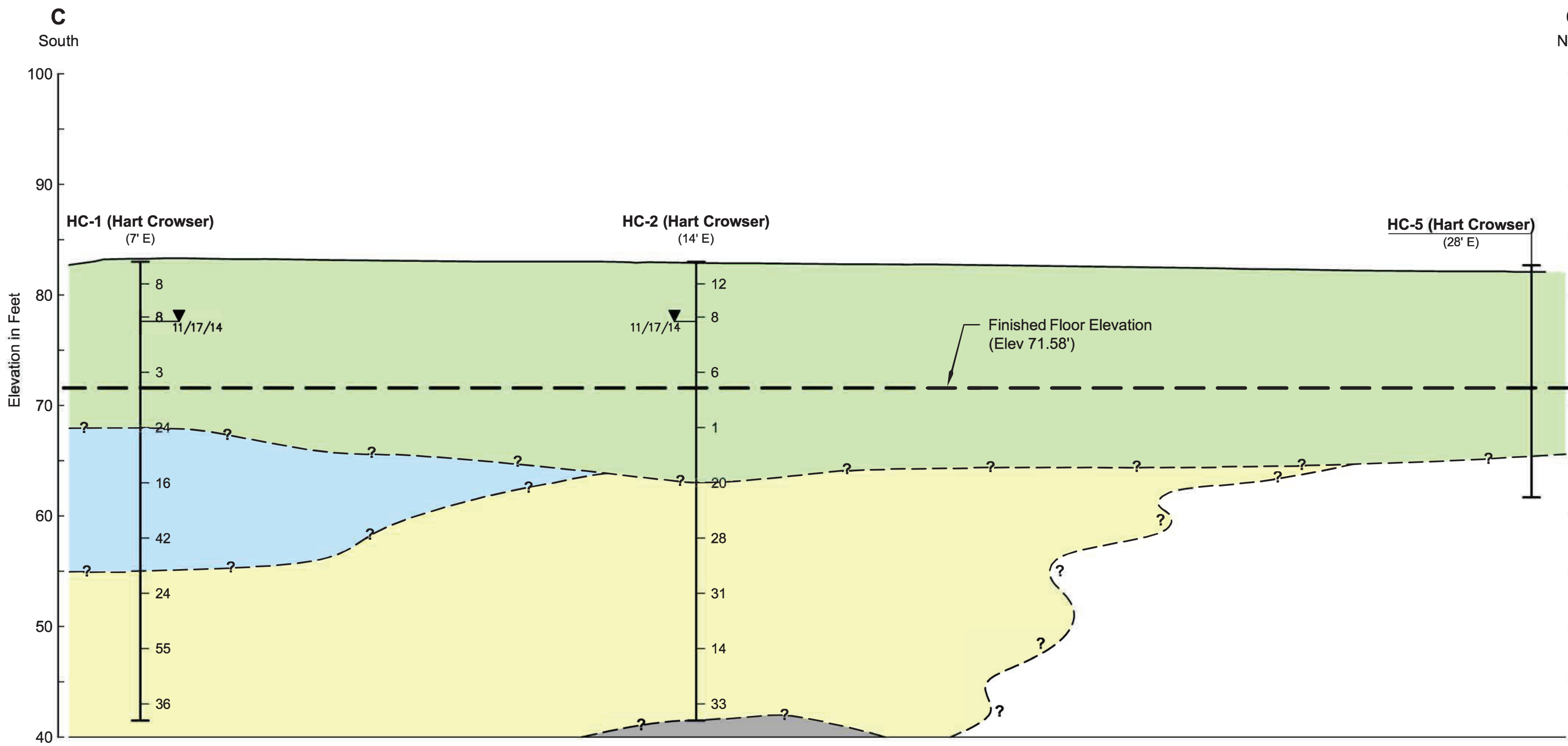
Figure
4

EAL 10/28/20 194130-003 (XSec).dwg



Legend

B-1 (Terra) (16' W) Exploration Number (Offset Distance and Direction)

Exploration Location

Water Level (ATD)

Standard Penetration Resistance in Blows per Foot (9)

Finished Floor Elevation Johnston Architects, LLC Plans dated 10/1/2020

Unit 1
Loose to medium dense granular FILL, soft SILT, and PEAT

Unit 2
Medium stiff to hard SILT and silty CLAY

Unit 3
Medium dense to dense SAND and silty SAND

Unit 4
Hard SILT

Horizontal Scale in Feet
0 20 40
0 10 20
Vertical Scale in Feet
Vertical Exaggeration x 2

Mercer Island Multi-Family Development
Mercer Island, Washington

Generalized Subsurface Cross Section C-C'

19413-00 10/20

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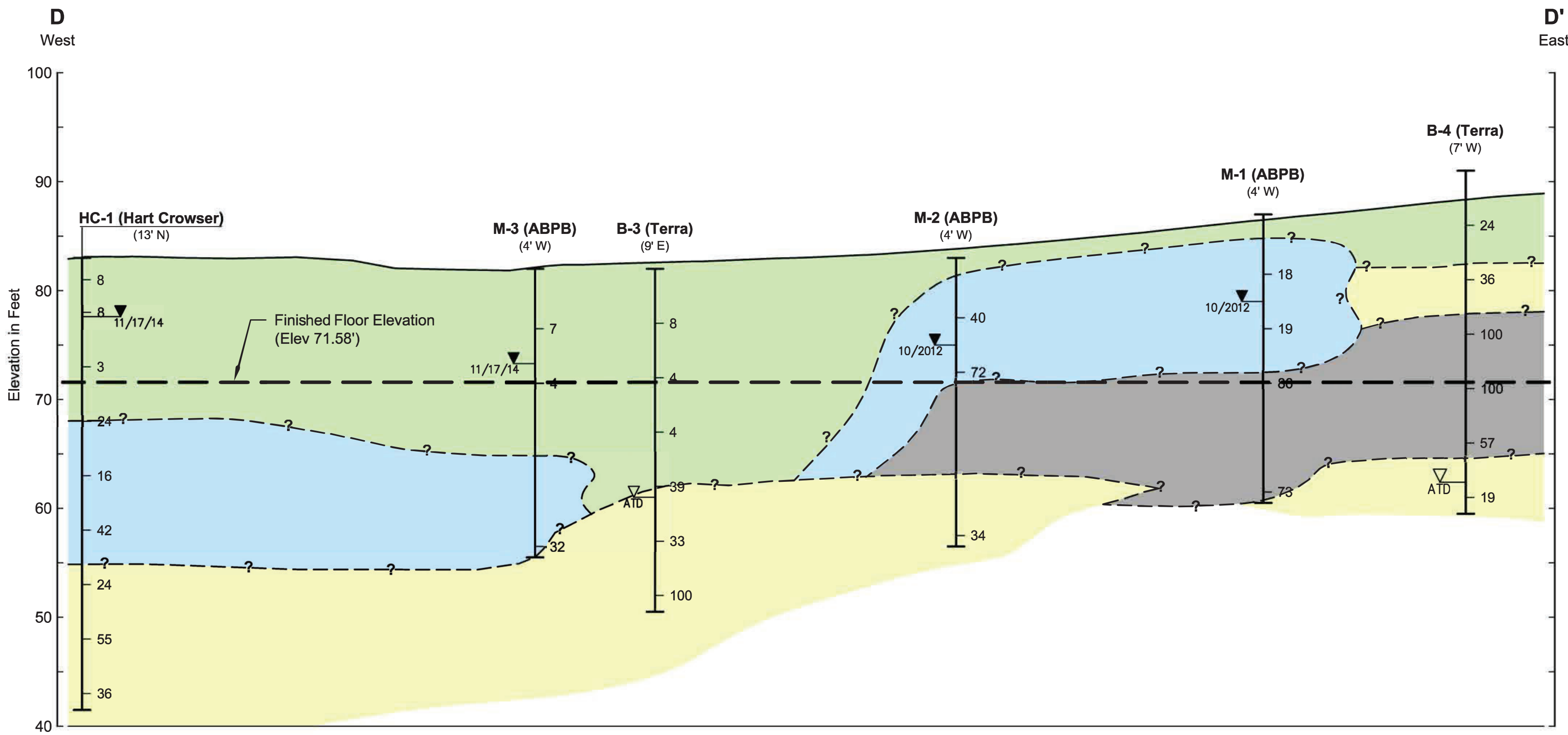
Figure
5

EAL 10/28/20 194130-004 (XSec).dwg



Legend

B-1 (Terra) (16' W)	Exploration Number (Offset Distance and Direction)
	Exploration Location
ATD	Water Level
9	Standard Penetration Resistance in Blows per Foot
	Finished Floor Elevation Johnston Architects, LLC Plans dated 10/1/2020

Unit 1	Loose to medium dense granular FILL, soft SILT, and PEAT
Unit 2	Medium stiff to hard SILT and silty CLAY
Unit 3	Medium dense to dense SAND and silty SAND
Unit 4	Hard SILT

Horizontal Scale in Feet
0 20 40

0 10 20
Vertical Scale in Feet
Vertical Exaggeration x 2

Mercer Island Multi-Family Development
Mercer Island, Washington

Generalized Subsurface Cross Section D-D'

19413-00 10/20

HARTCROWSER
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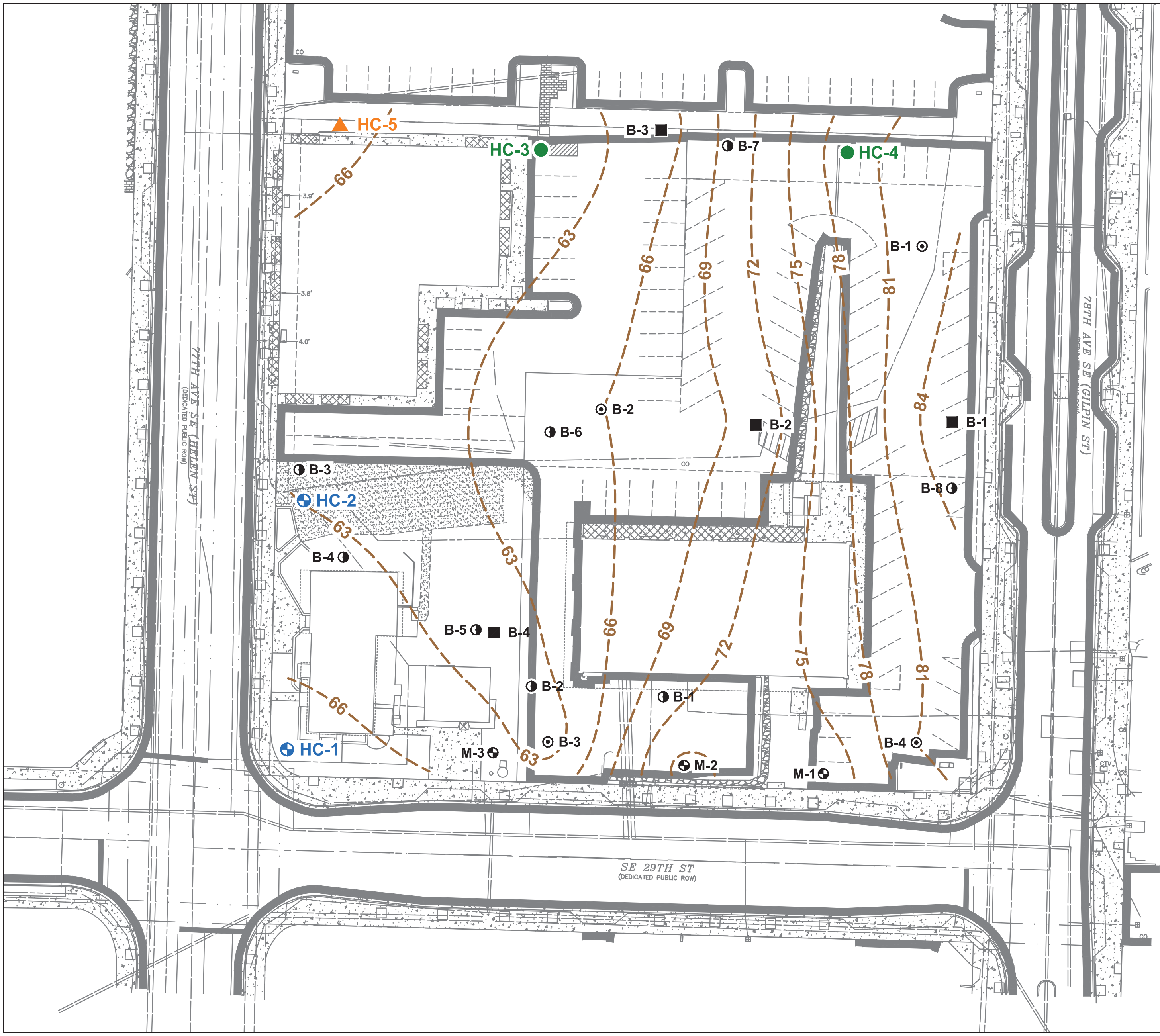
Figure
6

EAL 10/28/20 194130-005 (XSec).dwg



Current Exploration Location and Number

HC-3 ● Boring (Hart Crowser)
HC-5 ▲ DCP (Hart Crowser)
HC-1 Monitoring Well (Hart Crowser)

Previous Exploration Location and Number

B-1 ■ Boring (ABPB Consulting)
B-6 Push Probe (Farallon)
M-1 Monitoring Well (ABPB Consulting)
B-1 Boring (Terra)

84 — — Top of Competent Soils Contour Elevation in Feet

N

0 40 80
Scale in Feet

Source: Base map prepared from survey "XS-ALTA-02.dwg," created by Bush, Roed & Hitchings, dated 10/14/14.

Mercer Island Multi-Family Development
Mercer Island, Washington

Elevation of Top of Competent Soils

19413-00 10/20

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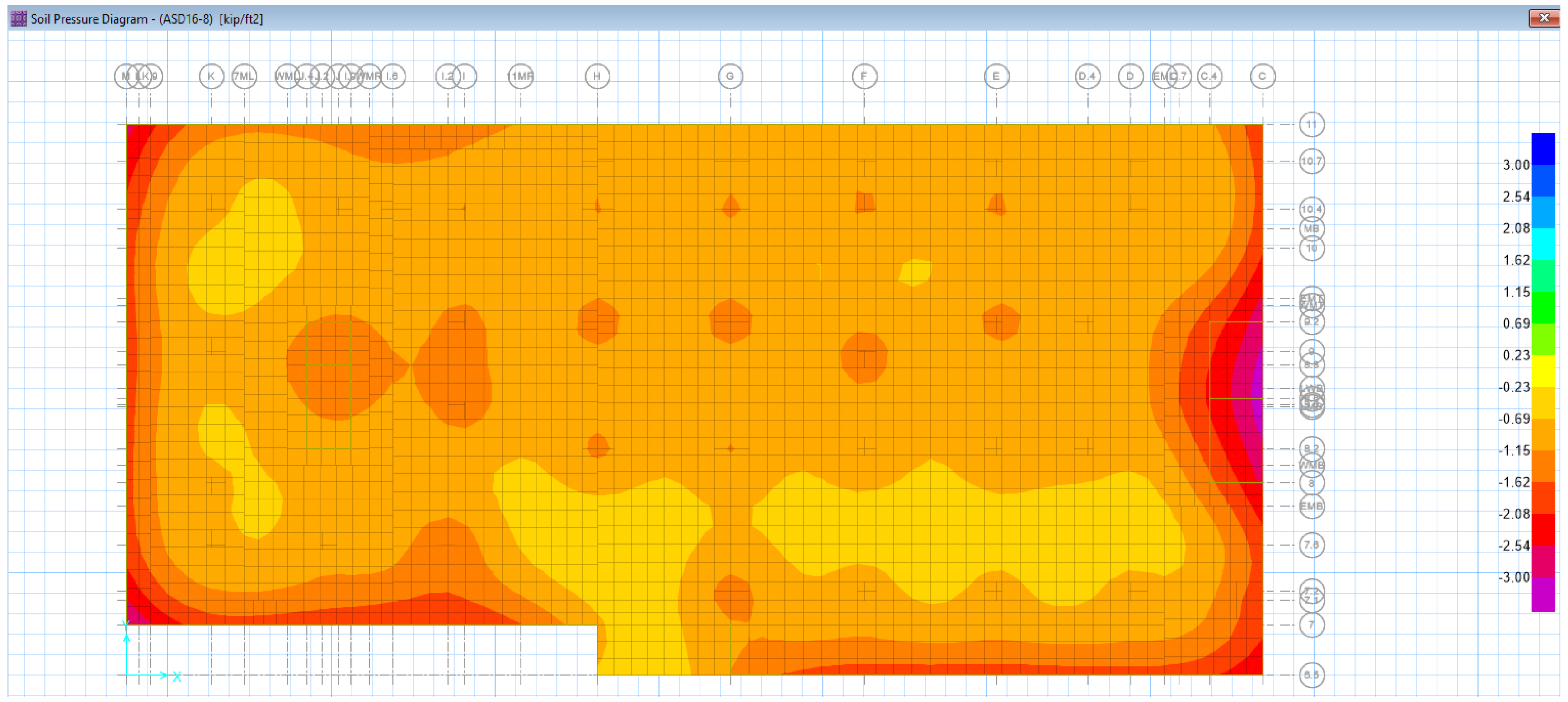
Figure
10

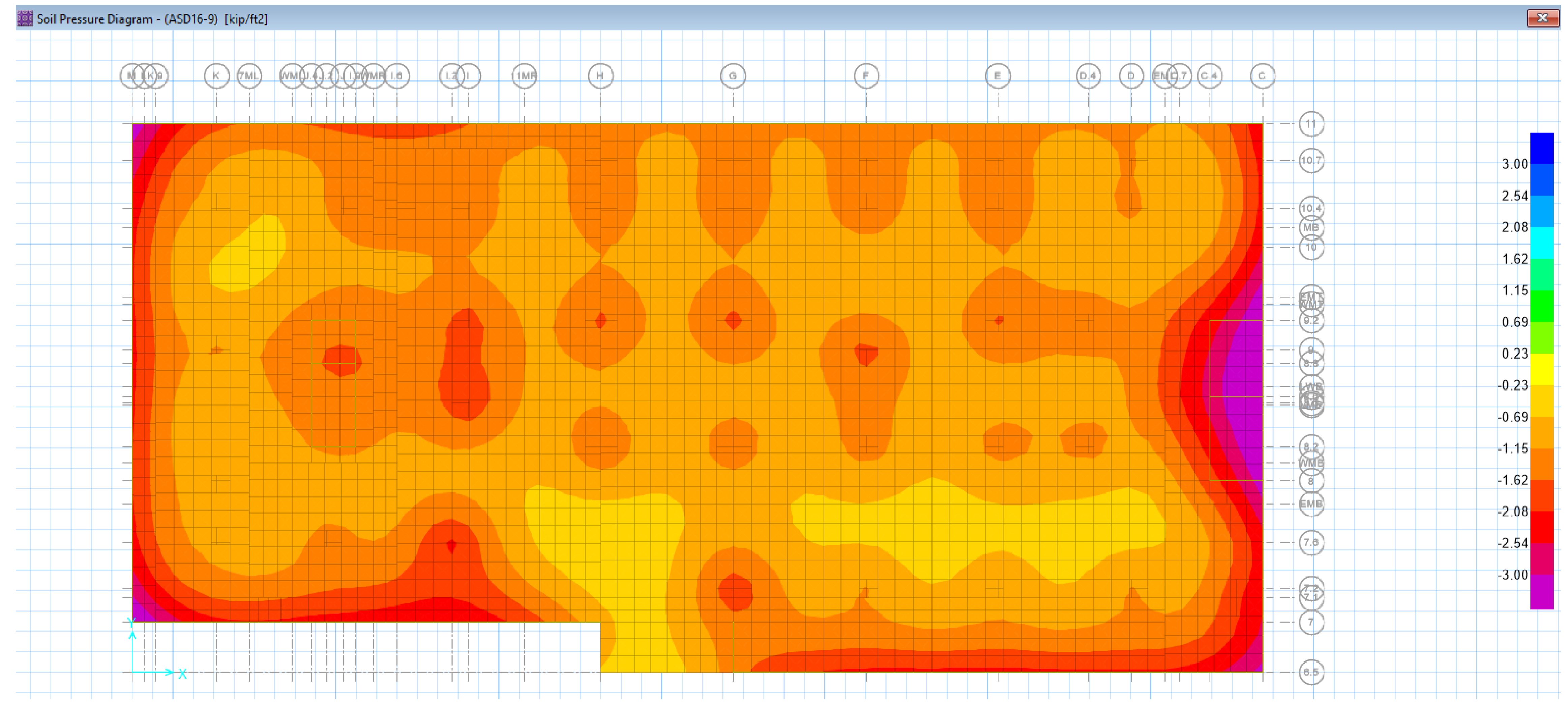
EAL 10/27/20 194130-006 (SPlan).dwg

Appendix B: Structural Loading

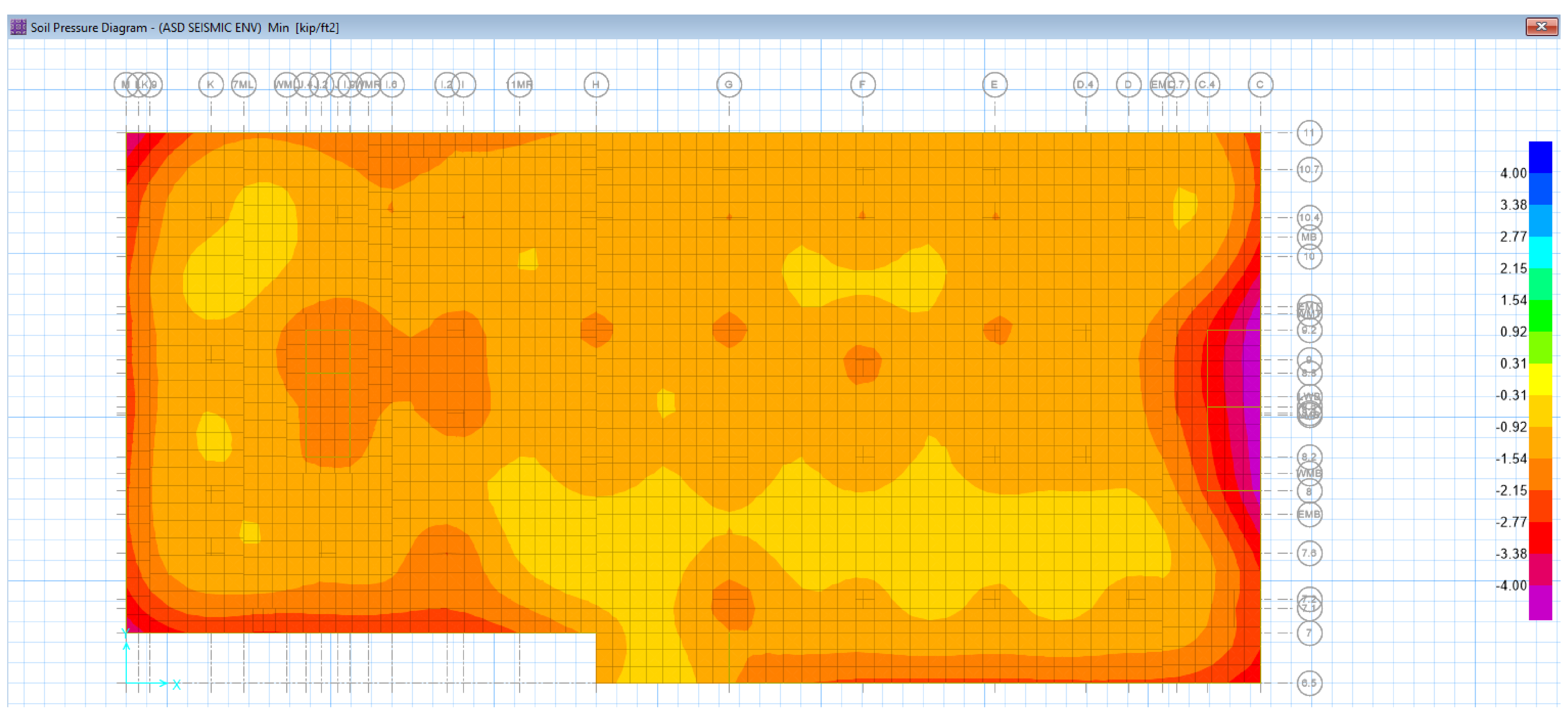
DEAD:



DEAD & LIVE ENV:



+ SEISMIC ENV:



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STAMP

PROJECT

MERCER ISLAND APARTMENTS

REVISION

DATE

JOB #

DRAWN

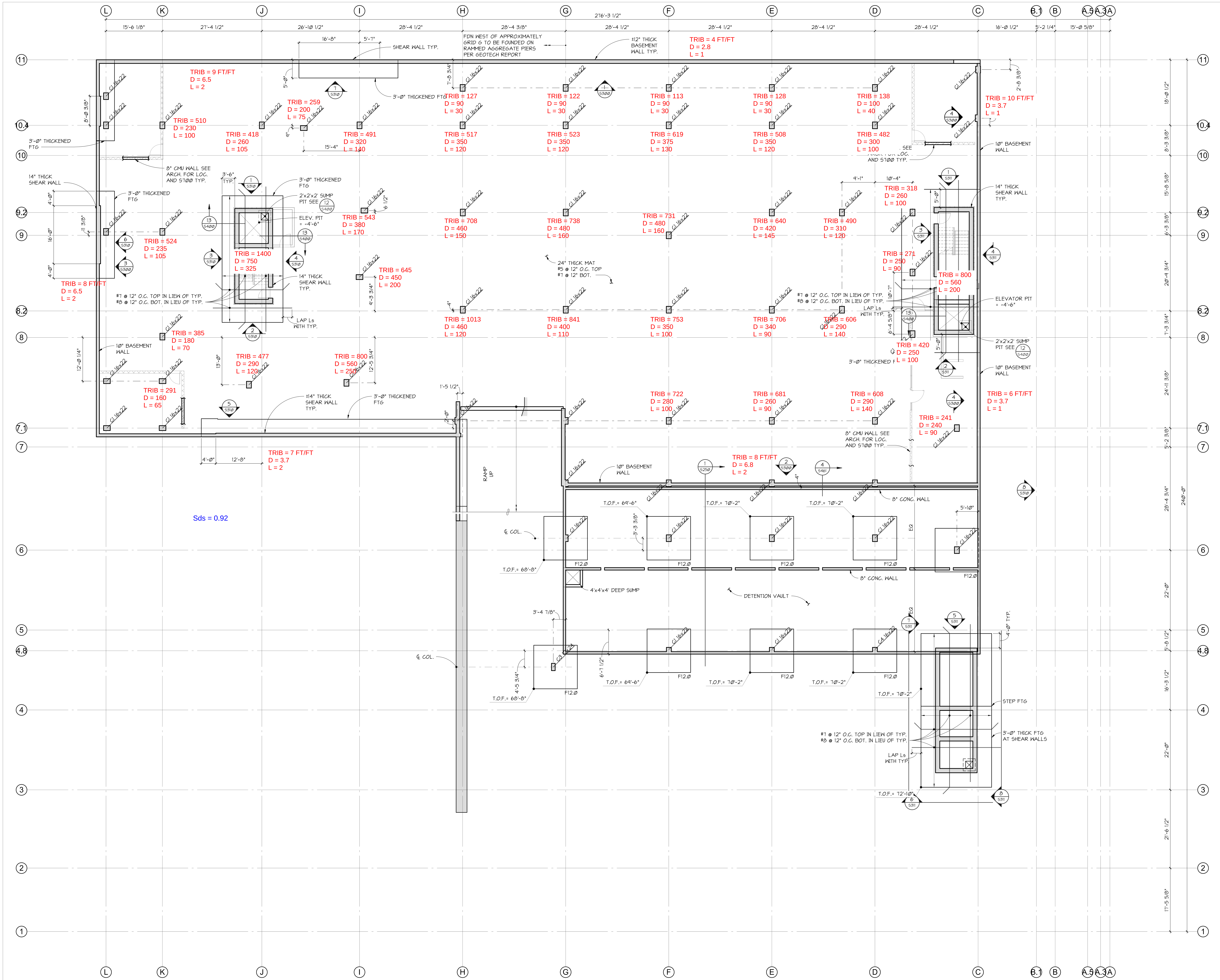
CHECKED

TITLE

LEVEL P2 MAT FOUNDATION PRESSURES

SHEET

SK-1



LEVEL P2 FOUNDATION PLAN
1/8" = 1'-0"

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100 NE Northlake Way,
Suite 200
Seattle, WA 98105
t 206.523.6150
f 206.523.9382

PCS Structural Solutions
Seattle | Tacoma | Portland
www.pcs-structural.com

MERCER ISLAND MIXED USE
2885 78TH AVE SE
MERCER ISLAND, WA 98040

DRAWING ISSUE

Date	Description
09/04/20	75% CD QA Set

SHEET TITLE
LEVEL P2 FOUNDATION PLAN

SHEET NO.
S200.1

Drawn Author
Checked Checker

Appendix C: Settlement Calculations

PROJECT: Mecer Island Mixed Use *Deep
NO:
DATE: 12/9/2020
ENGINEER: DVT

GEOPIER®

RAMMED AGGREGATE PIER ® DESIGN FOR MATS

Equivalent B = 185.7 ft.

Mat Width	115	ft
Mat Length	300	ft
Mat Area	34500	sq. ft.
Equiv Width, B	185.7	ft
Floor Pressure	1500	psf
Dgw	1	ft
γ soil	125	pcf
Hs	7	ft
Pier Diameter	24	inches

Rammed Aggregate Pier® Design:

								Center			Edge		
Spacing (feet o-c)	Layer Thickness	Ra	Em (ksf)	Eg (ksf)	Ecomp (ksf)	z (ft)	z/Beq	Influence Factor	ΔP (ksf)	S (inches)	Influence Factor	ΔP (ksf)	S (inches)
6.00	2	0.09	100	1400	213	1.0	0.01	1.00	1.50	0.2	1.00	1.50	0.2
6.00	2	0.09	100	1400	213	3.0	0.02	1.00	1.50	0.2	0.95	1.42	0.2
6.00	2	0.09	100	1400	213	5.0	0.03	1.00	1.50	0.2	0.87	1.31	0.1
6.00	1	0.09	100	1400	213	6.5	0.03	1.00	1.50	0.2	0.83	1.25	0.1
6.00	2	0.09	400	5000	801	8.0	0.04	1.00	1.50	0.0	0.77	1.16	0.0
	9												

Selected for Design:	6.00	0.09	0.7	0.7
	Spacing (ft)	Ra	Ctr UZ (in)	Edge UZ (in)

Lower Zone:

											Center			Edge		
Layer	Soil Type		Esoil ksf	Cεr	Cεc	OCP ksf	Thickness ft	z ft	σ'v psf	z/Beq	Iσ Center	ΔP ksf	S (Center) in	Iσ Edge	ΔP ksf	S (Edge) in
UZ	GP-CL						9.0	4.5					0.7			0.7
1	ML			0.005		9.39	10	14.00	939	0.08	1.00	1.50	0.25	0.66	0.99	0.2
2	ML			0.005		15.65	10	24.00	1565	0.13	0.99	1.48	0.17	0.60	0.90	0.1
3	ML			0.0025		82.00	71	64.50	4100	0.35	0.85	1.28	0.25	0.49	0.73	0.2
							100.0									

Center		Edge	
UZ (in) =	0.7	UZ (in) =	0.7
LZ (in) =	0.7	LZ (in) =	0.5
Total Center (in) =	1.4	Total Edge (in) =	1.1

PROJECT:	Mecer Island Mixed Use	*Shallow
NO:		
DATE:	12/9/2020	
ENGINEER:	DVT	

GEOPIER®

RAMMED AGGREGATE PIER® DESIGN FOR MATS

Equivalent B = 185.7 ft.

Mat Width	115	ft
Mat Length	300	ft
Mat Area	34500	sq. ft.
Equiv Width, B	185.7	ft
Floor Pressure	1500	psf
Dgw	1	ft
γ soil	125	pcf
Hs	1	ft
Pier Diameter	24	inches

Rammed Aggregate Pier® Design:

								Center			Edge		
Spacing (feet o-c)	Layer Thickness	Ra	Em (ksf)	Eg (ksf)	Ecomp (ksf)	z (ft)	z/Beq	Influence Factor	ΔP (ksf)	S (inches)	Influence Factor	ΔP (ksf)	S (inches)
6.00	0.5	0.09	100	1400	213	0.3	0.00	1.00	1.50	0.0	1.00	1.50	0.0
6.00	0.5	0.09	100	1400	213	0.8	0.00	1.00	1.50	0.0	1.00	1.50	0.0
6.00	0.5	0.09	100	1400	213	1.3	0.01	1.00	1.50	0.0	1.00	1.50	0.0
6.00	0.5	0.09	100	1400	213	1.8	0.01	1.00	1.50	0.0	1.00	1.50	0.0
6.00	1	0.09	400	5000	801	2.5	0.01	1.00	1.50	0.0	0.98	1.47	0.0
	3												

Selected for Design:	6.00	0.09	0.2	0.2
	Spacing (ft)	Ra	Ctr UZ (in)	Edge UZ (in)

Lower Zone:

											Center			Edge		
Layer	Soil Type		Esoil ksf	Cεr	Cεc	OCP ksf	Thickness ft	z ft	σ'v psf	z/Beq	Iσ Center	ΔP ksf	S (Center) in	Iσ Edge	ΔP ksf	S (Edge) in
UZ	GP-CL						3.0	1.5					0.2			0.2
1	ML			0.005		5.63	10	8.00	563	0.04	1.00	1.50	0.34	0.77	1.16	0.3
2	ML			0.005		11.89	10	18.00	1189	0.10	1.00	1.49	0.21	0.63	0.94	0.2
3	ML			0.0025		78.25	77	61.50	3912	0.33	0.87	1.30	0.29	0.49	0.74	0.2
							100.0									

Center		Edge	
UZ (in) =	0.2	UZ (in) =	0.2
LZ (in) =	0.8	LZ (in) =	0.6
Total Center (in) =	1.0	Total Edge (in) =	0.8

Appendix D: Bearing Capacity

GEOPIER BEARING CAPACITY ANALYSIS

GEOPIE

Run Date: 2/8/2022 17:40

PROJECT: Mercer Island Mixed Use

Reference: Technical Bulletin No. 2, "Bearing Capacity of Geopier-Reinforced Founhdation Systems", by Geopier Foundation Co., Inc. (1999)

Footing Data:

Design Bearing Pressure	q	=	3,000	(psf)
Footing Length	L	=	300.00	(ft)
Footing Width	B	=	115.00	(ft)
Footing Depth	D_f	=	2.00	(ft)
Pier Diameter		=	24	(in)
Number of Piers		=	958.0	
Pier Modulus	K_{Gp}	=	125	(pci)
Depth to GWL Below Finish Floor		=	1.0	(ft)

Total Column Load (kips)	=	103,500
Footing Area (sq. ft)	=	34,500.00
Total Pier Area (sq. ft)	=	3,008.12
Area Ratio	=	0.087
Stess Applied to Piers (psf)	=	16,809
Stress Applied to Matrix Soil (psf)	=	1,681
Relative Stiffness Ratio	=	10
Individual Pier Load (kips)	=	52.78

Matrix Soil Data:

					Lower Zone:	
UZ Soil Modulus	K_s	=	13	(pci)		
Allowable Bearing Pressure		=	1,500	(psf)		
Undrained Strength	S_u	=		(psf)		(psf)
Cohesion	c	=	200	(psf)	500	(psf)
Friction Angle	Φ_s	=	26	(degrees)	34	(degrees)
Unsubmerged Unit Weight:						
Above D_f	γ_2	=	120	(pcf)		
Below D_f	γ_1	=	120	(pcf)		

Geopier Data:

Pier Diameter	d	=	2.0	(ft)	
Effective diam.	d_e	=	2	(ft)	*** effective shaft diam. = nominal diam. + 6"*
Shaft Drill Depth		=	8	(ft.)	** Assumed Average Shaft Length
Effective Shaft	$H_{eff.}$	=	10.0	(ft.)	*** effective pier length for soil bearing capacity a*
Modulus	k_{gp}	=	125	(pci)	
Friction Angle	Φ_{gp}	=	48	(degrees)	
Unit weight:					
Unsubmerged	γ_{gp}	=	135	(pcf)	
Design	γ_{gp}	=	73	(pcf)	
Pier Area	A_{gp}	=	3,008.12	(sq. ft.)	
Area Ratio	R_A	=	0.087	(Af/Agp)	
Stiffness Ratio	R_s	=	10		
Top-of-pier Stress	σ_{gp}	=	16,809	(psf)	

A. Shearing Below the Tip of Individual Geopier Element:

predominantly clayey soils where essentially **undrained** *conditions apply*

Ultimate Top-of-pier stress	q_{ult}	=	0	psf	$q_{ult} = 4s_u d_e H_{eff.}/d^2 + 9s_u$ *(Eq.11.)*
For Design Pier Stress = 16809 psf		**=**	**0.00**		

predominantly silty and/or sandy soils where essentially **drained** *conditions apply*

Effective shaft diameter	d_e	=	2.5	ft	*(effective shaft diam. = nominal diam. + 6")*
Crossectional area of Geopier element	A_g	=	3.1	ft2	$Ag = \Pi d_2/4$
Average unit shaft friction (drained)	f_s	=	504	psf	$f_s = (d_f+H_{eff.}/2)\gamma \tan(\Phi_s)\tan^2(45+\Phi_s/2)$ *(Eq.12)*
Effective area of Geopier element shaft	A_{shaft}	=	79	ft2	$A_{shaft} = \Pi d_e H_{eff.}$
Ultimate shaft frictional capacity (drained)	q_{shaft}	=	12,591	psf	$q_{shaft} = f_s A_{shaft}/A_g$
	Qshaft	=	<u>39,556</u>	pounds	$Q_{shaft} = f_s A_{shaft}$
Effective overburden stess @ pier tip	σ_{vtip}	=	754	psf	
Bearing Capacity Factors: Φs = 34 degrees					*(Use Meyerhof factors for bearing capacity below individual piers)*
cohesion	N_c	=	145		
friction	N_γ	=	0		
embedment	N_q	=	65		
Ultimate bearing Capacity at pier tip (drained	q_{tip}	=	121,484	psf	$q_{tip} = cN_c+(0.5)d_e\gamma N_\gamma+\sigma_{vtip}N_q$ *(Eq.9)*
Ultimate tip capacity (drained):	Q_{tip}	=	<u>381,653</u>	pounds	$Q_{tip} = q_{tip} A_g$
Ultimate Top-of-Pier Stress	q_{ult}	=	134,075	psf	$q_{ult} = (Q_{shaft} + Q_{tip})/A_g$
For Design Pier Stress = 16809 psf	**FS**	**=**	**7.98**		

GEOPIER®

B. Shearing Within The Geopier-Reinforced Soil Matrix:

Composite Soil Strength Parameters:

R_a Reduction Factor	=	0.4		Effective R_a = 0.03
Soil Stress Concentration Factor	=	2.5		(Reduced R_s to account for vert. stress decrease with depth)
$\Phi_{comp.}$	=	28	degrees	
$C_{comp.}$	=	0	psf	(based on value entered for Su)
	=	183	psf	(based on value entered for C)

$$q_{ult.} = k_1(C_{comp.}N_c) + k_2(\gamma_1 B N_\gamma) + \gamma_2 D_f N_q$$

where:

k_1	=	1	k_1 = 1.3 for square and rectangular footings; and 1.0 for continuous footings
k_2	=	0.5	k_2 = 0.5 for sauare, rectangular and continuous footings
N_c	=	30	(Terzaghi General Shear Factors)
N_γ	=	15	
N_q	=	17	

$q_{ult.}$ =	$k_1(C_{comp.}N_c)$	+ $k_2(\gamma_1 B N_\gamma)$	+ $\gamma_2 D_f N_q$	
$q_{ult.}$ =	5,477	49,680	4,080	
$q_{ult.}$ =	59,237	psf		

For Design Footing Stress = 3000 psf **FS = 19.7**

C. Shearing Below The Bottom of The Geopier-Reinforced Soil Matrix:

Depth below FF to btm.of Geopier-reinforced zone	H	=	12.0	feet		
Effective stress at btm.of Geopier-reinf. zone	σv-uz/lz	=	754	psf		
Stress induced from footing @ UZ/LZ plane	q_{bottom}	=	2,612	psf	q_{bottom} = q{BL/[(B+H)(L+H)]}	*(Eq. 15)*

predominantly clayey soils where essentially **undrained** *conditions apply*

Undrained strength of soil below UZ/LZ plane	S_u	=	0	psf		
Stress induced from footing @ UZ/LZ plane	q_{bottom}	=	2,612	psf	q_{bottom} = q{BL/[(B+H)(L+H)]}	*(Eq. 15)*
For Design Footing Stress = 3000 psf	**FS**	**=**	**0.0**			

predominantly silty and/or sandy soils where essentially **drained** *conditions apply*

Bearing Capacity Factors: Φs = 34 degrees *(Use Terzaghi local shear factors for shearing below the reinforced zone)*

cohesion	N_c	=	21			
friction	N_γ	=	8			
embedment	N_q	=	10			
Ultimate bearing capacity @ UZ/LZ (drained)	$q_{ult.}$	=	73,236	psf	qult = $cN_c+(0.5)B\gamma N_\gamma+\sigma_{v\text{-}uz/lz}N_q$	*(Eq.9)*
Stress induced from footing @ UZ/LZ plane	q_{bottom}	=	2,612	psf	q_{bottom} = q{BL/[(B+H)(L+H)]}	*(Eq. 15)*

For Design Footing Stress = 3000 psf **FS = 28.0**